Equation Derivation and Verification Procedure
Penrose Objective Reduction (OR)

I. Equation Derivation

The canonical Penrose Objective Reduction hypothesis defines the collapse timescale as tau ≈ hbar / E_G, where E_G is the gravitational self-energy associated with the difference between spacetime geometries of superposed mass configurations.

To formalize this relation in operator form, we define a structural curvature-energy functional K_struc, which reduces to E_G in the minimal limit. This yields the base operator T_OR = hbar / K_struc.

Additional operators are introduced to explicitly encode conservation, information locality, deterministic selection, and vacuum screening. These constraints are implicit in Penrose's original framework but are formalized here for completeness.

The complete expression is constructed as a multiplicative composition of dimensionless constraint operators acting on the base collapse timescale.

II. Verification and Test Procedure

Test 1: Dimensional Consistency. Verify that K_struc carries units of energy, ensuring that T_OR has units of time. All auxiliary operators must be dimensionless or properly normalized.

Test 2: Conservation Laws. Confirm that no operator introduces net energy, momentum, or information gain. Any zero-point field contribution must function strictly as a screening mechanism.

Test 3: Causality and Locality. Demonstrate that collapse triggering depends solely on local or quasi-local geometric thresholds and cannot be externally controlled to enable superluminal signaling.

Test 4: Phenomenological Testability. Identify experimental regimes, such as mesoscopic optomechanical systems, where deviations from standard decoherence timescales could be measured and compared to predicted collapse rates.

Successful completion of all four tests establishes the formulation as mathematically consistent, physically admissible, and suitable for archival and experimental consideration.